

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference A25731 WO	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 00/01052	International filing date (day/month/year) 21/03/2000	(Earliest) Priority Date (day/month/year) 24/03/1999
Applicant BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of Invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

P B 00/01052

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K9/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 97 16799 A (GENOSSAR OMRY ;BARON EHUD (IL); BARON TECH LTD (IL)) 9 May 1997 (1997-05-09) abstract; figure 8 * page 15, last paragraph * * page 22, paragraph "STEP 330" *	1-4
Y	US 4 736 445 A (GUNDERSEN STEVEN C) 5 April 1988 (1988-04-05) column 41, line 60 -column 5, line 22	1-4
Y	WO 97 44758 A (INST OF SYSTEMS SCIENCE ;APPLE COMPUTER (US)) 27 November 1997 (1997-11-27) abstract	2



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

28 June 2000

Date of mailing of the international search report

05/07/2000

Name and mailing address of the ISA

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Sonius, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

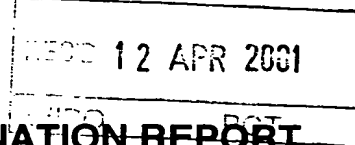
PC 8 00/01052

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9716799	A	09-05-1997	AU	7330596 A	22-05-1997
US 4736445	A	05-04-1988	JP	62172478 A	29-07-1987
WO 9744758	A	27-11-1997	AU	3211897 A	09-12-1997
			CA	2252370 A	27-11-1997

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



14


Applicant's or agent's file reference A25731 WO		FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB00/01052	International filing date (day/month/year) 21/03/2000	Priority date (day/month/year) 24/03/1999	
International Patent Classification (IPC) or national classification and IPC G06K9/22			
Applicant BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY			

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 6 sheets, including this cover sheet.
 - ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

- This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 18/09/2000	Date of completion of this report 10.04.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Herter, J Telephone No. +49 89 2399 7478



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/01052

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-5 as originally filed

Claims, No.:

1-4 as originally filed

Drawings, sheets:

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/01052

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2
	No:	Claims	1,3,4
Inventive step (IS)	Yes:	Claims	
	No:	Claims	2,3
Industrial applicability (IA)	Yes:	Claims	1-4
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/01052

1. Reference is made to the following documents:

D1: WO 97/16799 A (Baron Ehud et al) 9 May 1997

D2: US-A-4 736 445 (Gundersen Steven C) 5 April 1988

D3: WO 97/44758 A (Apple Computer) 27 November 1997

2. **Item V: Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

- 2.1 The present application fails to meet the requirements of Article 33(2) PCT because the subject matter of claims 1 and 4 is not novel, the reasons being as follows:

As to claim 1:

D2 discloses:

- A handwriting recognition system (see column 3, lines 30-31) comprising:
- means responsive to input analogue signals representative of movement of a hand held writing device (see column 4, lines 8-19);
- sampling means to provide signals representative of the acceleration of the writing device in at least x axis and y axis channels at a predetermined capture sampling rate (see column 4, lines 8-19); and
- filtering means to remove DC level components and to provide smoothing of the output whereby signals representative of the movement of the pen over a period are supplied to a classifier for comparison with a template representative of characters formed (see column 4, line 60 - column 5, line 22 supported by column 5, lines 50-64).

This is the wording of present claim 1, the subject-matter of which consequently is not novel (Article 33(2) PCT).

As to claim 4:

D2 discloses:

- A method of analysing signals from a moving hand held device (see column 3, lines 30-31 supported by column 4, lines 8-11 and column 1, lines 6-11), the method comprising:
- sampling signals at a predetermined rate (see column 4, lines 8-19),
- passing signals through a bandpass filter to remove DC level and excess acceleration components (see column 4, line 60 - column 5, line 22),
- sampling the filtered output to provide a series of vectors representing the position of the hand held device at periodic intervals (see column 5, lines 4-6 supported by column 5, lines 31-34) and
- using a classifier to compare the sample sets with predetermined templates to determine the character for output (see column 5, lines 50-64).

This is the wording of present claim 4, the subject-matter of which consequently fails to meet the requirements of Article 33(2) PCT for lack of novelty.

- 2.2 Dependent claims 2 and 3 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to novelty and inventive step, the reasons being as follows:

As to claim 2:

D2 does not disclose that the classifier uses a hidden Markov model for comparison purposes. This, however, can be found in document D3, which the skilled person will surely be aware of since both documents D2 and D3 belong to field of handwriting recognition. D3 discloses a recognition system for hand-written ideographic characters which consist of a number of subcharacters using hidden Markov models. By combining D2 and D3 the skilled person will consequently arrive at claim 2 without the exercise of an inventive step.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/01052

As to claim 3:

D2 further discloses:

the sampling means, filtering means and classifier are implemented in a digital computer environment (see column 4, lines 24-31 supported by figure 1).

This is the wording of present claim 3, the subject matter of which consequently is not novel (Article 33(2) PCT) and does not involve an inventive step in the sense of Article 33(3) PCT when regarded in combination with present claim 2.

3. **Item VII: Certain defects in the international application**

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

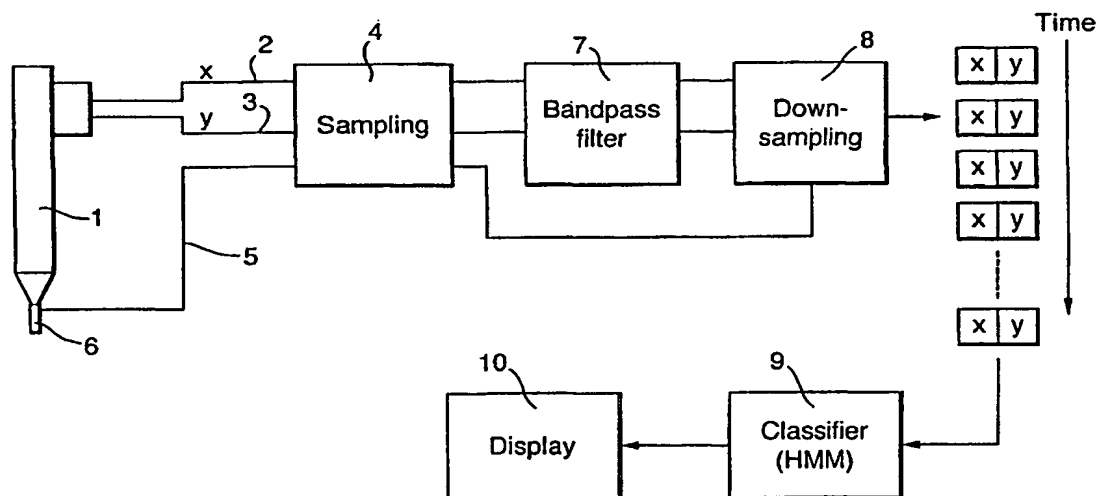
Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1, D2 and D3 is not mentioned in the description, nor are these documents identified therein.



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : G06K 9/22	A1	(11) International Publication Number: WO 00/57349 (43) International Publication Date: 28 September 2000 (28.09.00)
(21) International Application Number: PCT/GB00/01052 (22) International Filing Date: 21 March 2000 (21.03.00) (30) Priority Data: 99302270.6 24 March 1999 (24.03.99) EP (71) Applicant (for all designated States except US): BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY [GB/GB]; 81 Newgate Street, London EC1A 7AJ (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): MILNER, Benjamin, Peter [GB/GB]; 16 Armstrong Road, Thorpe St. Andrew, Norwich, Norfolk NR7 9LJ (GB). (74) Agent: BRADLEY, David, William; BT Group Legal Services, Intellectual Property Dept., 8th floor, Holborn Centre, 120 Holborn, London EC1N 2TE (GB).		(81) Designated States: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: HANDWRITING RECOGNITION SYSTEM



(57) Abstract

In order to improve the accuracy of recognition of hand-written input using a stylus (1), output signals from a plurality of accelerometers representing x and y axis acceleration and deceleration are sampled at a predetermined rate and passed through a digital bandpass filter (7) to remove high frequency components and dc components arising from gravity. x and y vectors derived from the original x and y input signals are passed to a classifier using a hidden Markov model. Bandpass filtering improves the robustness of the interpretation of the vectors against stored templates which may be templates of individual characterisations or of whole words.

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HANDWRITING RECOGNITION SYSTEM

The present invention relates to a handwriting recognition system and more particularly to a hardware and an algorithm for implementing such a system.

5 In PCT application number GB98/0316 (Publication No. WO99/22338) there is disclosed a portable computer in the form of a pen-type casing. Incorporated within the casing is at least one accelerometer which is used to detect movement of the pen with respect to its environment. By using the instrument for handwriting it is possible to effect data entry or transmission of signals reflecting movement, the user
10 using either a pen tip mounted switch or a finger operated switch to indicate that movement is effecting a written input.

There are many other pen-type input devices on the market in addition to stylus scroll pallets typically used in so-called palm top computers where handwriting recognition has been used. Such devices often require very precise movement which
15 may not reflect natural handwriting movements for the user. One of the problems which makes characteristic handwriting recognition difficult is that while the underlying movement made by an individual to represent a particular letter may be consistent an element reflecting user movements due to stress and other factors will be present.

20 According to the present invention there is provided a handwriting recognition system comprising means responsive to input analogue signals representative of movement of a handheld writing device, sampling means to provide signals representative of the acceleration of the writing device in at least x axis and y axis channels at a predetermined capture sampling rate, and filtering means to
25 remove dc level components and to provide smoothing of the output whereby signals representative of movement of the pen over a period are supplied to a classifier for comparison with a template representative of characters formed.

The classifier may use hidden Markov modelling (HMM) techniques using a large number of states to determine the character defined by movement. The system
30 may include an input indicative of a user's intention that the movement is representative of character writing.

According to a feature of the present there is provided a method of analysing signals from a moving handheld device, the method comprising sampling signals at a

predetermined rate, passing signals through a bandpass filter to remove dc level and excess acceleration components, sampling the filtered output to provide a series of vectors representing the position of the handheld device at periodic intervals and using a classifier to compare the sample sets with predetermined templates to
5 determine the character for output.

A handwriting recognition system in according with the invention will now be described by way of example only with reference to the accompanying drawing of which:

Figure 1 is a block schematic diagram of the system;

10 Figure 2 shows relative positioning of the x and y axis of the handwriting device of Figure 1;

Figure 3 is a schematic diagram of the handheld writing device of Figure 1 in a particular position;

Figure 4 shows relative input and output vector streams from the system of
15 Figure 1; and

Figures 5 to 9 show comparative templates for a number of different letters.

Referring first to Figure 1, an input device 1 such as a stylus produces x and y vector streams 2 and 3 which are fed into a sampling unit 4. The outputs x and y are generally from accelerometers or other position sensing devices within the stylus
20 1. Also feeding the sampling unit 4 is an output 5 from a switch indicated here as being in the nib section of the stylus 1 such that contact between the switch 6 and a surface is indicative of the stylus being used in a writing mode. It will be appreciated that the nib switch 6 when incorporated in a non-surface contacting stylus, such as that disclosed in the previously referred PCT application, may be replaced by a user
25 operable switch.

The output of the sampling unit 4, which samples the incoming streams at 60 Hz for example, is passed to a bandpass filter arrangement 7 and thence to a down sampling unit 8 which produces digitised vectors x and y over a period of time. The x and y vectors are passed to a classifier 9, which uses a hidden Markov model
30 to carry out a comparison between the vectors and templates representing written characters. The classifier 9 may be arranged to output to a visual display 10.

More specifically, the stylus 1 for example comprises a simple plastic casing containing the electronics for transferring information to a PC. Two accelerometers

mounted in the stylus, for example, are used to produce the x and y outputs. The nib switch is a simple on/off switch connected to determine when pressure is being applied to the pen nib and can therefore detect when a pen for stylus 1 is writing.

Turning briefly to Figure 2, the two accelerometers mounted in the top of the pen measure acceleration across their plane such that effectively they measure acceleration along the x axis 11 and the y axis 12 of the writing surface 14. The acceleration measured by the sensors is made up of two components, acceleration due to gravity and the acceleration as a result of stylus movement. It will be appreciated that the acceleration due to gravity is always present, such that when the pen is exactly horizontal both sensors would measure acceleration of 1g. As the angle of the pen to the horizontal changes (as shown for example in Figure 3), the accelerometers are subject to $\sin \theta \times 1g$ where θ is the inclination angle of the stylus 1.

The other component, acceleration as a result of the pen moving is produced by the acceleration and deceleration effect as the user writes.

The acceleration of the two sensors x_{total} and y_{total} can be expressed as

$$y_{total} = y_g + y_{movement} \text{ and } x_{total} = x_g + x_{movement}$$

The remaining items of Figure 1 are incorporated in a computer unit, for example a PC, and three signals, as previously indicated, 2, 3 and 5 being the two acceleration signals and binary signal from the pen switch are provided to the PC.

In one embodiment the two acceleration signals are read into a normal PC using an RS232 port and the binary switch signal by means of the games port of a sound card.

The sampling section must sample sufficiently regularly to capture the movement of the pen but should not over-sample, which would result in a waste of processing and storage within the PC. It has been found satisfactory for the purposes of the current invention to sample at a rate of 60 Hz. The acceleration signals for each channel are read in as two byte words giving a dynamic range for each acceleration signal from 0 to 65535. The pen nib switch is similarly sampled at the same rate.

As previously mentioned, the accelerometer signals are partly dependent on a component of the earth's gravitation field passing through the accelerometer of the stylus 1. This results in an almost constant dc level present on the output corresponding to the average pen angle θ while writing. The bandpass filter 7 is thus arranged to filter the signals from the two accelerometers to remove the offsets. Additionally, the bandpass filter smoothes the output from the sensors thus correcting for instability introduced by the user so that the smoothed output from the sensors increases robustness and facilitates matching between the x and y vectors and stored templates.

Turning now to Figure 4, for each sample received on the PC from the accelerometers, the pen nib switch (or manually operable switch) indicates whether the stylus 1 was being used in a writing mode or not. The down sampling process 8 uses the information to down sample acceleration samples and to retain only those when it was known that the stylus 1 was writing. Thus, consider Figure 4, assuming that the x axis and y axis vectors are as shown at 15 and 16, then the down sampling vectors need only be taken into account when the nib switch signal indicator 17 is high. This will reduce the number of samples significantly so that the output from the down sampling process is a time series of two dimensional vectors x and y as indicated at 18 and 19.

Having completed processing of the acceleration measurement from the stylus 1 the vector stream is passed to the classifier stage 9 which takes in a series of vectors representing the acceleration measurements made within a given word. These are then compared to a set of templates which cover the range of words within the system vocabulary and the word which matches most closely with the unknown input word is deemed the recognised word. In this system the classifier is a hidden Markov model. Such models have been widely used in speech recognition and using a large number of states in the hidden Markov model will give the best performance for corresponding handwriting recognition.

The display 10, which displays the output from the PC allows display of a word, for example, on a screen.

While the above handwriting recognition system is intended for use with a series of known words which, depending on the system vocabulary entered into the PC, may be a large number, it will be possible to use the same kind of system to

validate single character entry. Using single character recognition and using cursive entry it is still possible to build individual words which may not be present in the vocabulary. There may be a lower level of confidence in words created rather than template determined. However, over time, the vocabulary may be expanded where
5 multiple entries of the same word have occurred such that higher confidence levels may be achieved.

A typical single accelerometer output can be seen respectively for the letters c, b, f and h in Figures 5 to 8. In each case the template developed here shows three entries on a single accelerometer for each of the letters.

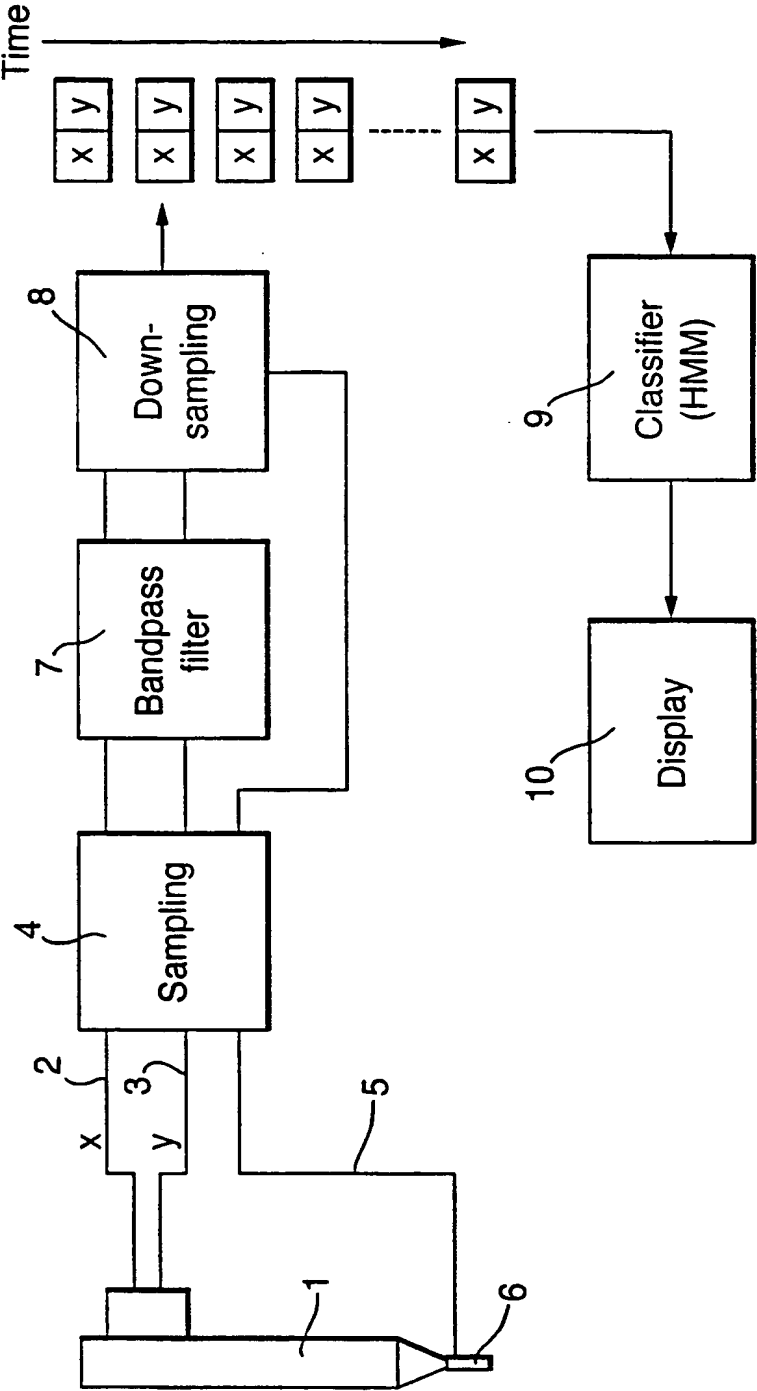
10 In Figure 9, f, b, h and c are shown in comparison so that a suitable template for comparison may be derived. It will be appreciated that the combination of an x accelerometer trace and a y accelerometer trace will serve further to emphasise the difference between each input letter.

Bandpass filtering in digital form to remove dc components and high
15 frequency components increases the reliability of the recognition process and therefore the reliability of the interpretation of the stylus input 1. It will be appreciated that where the stylus 1 carries other components, for example an internal processing arrangement, some of the functions may be transferred from the PC to the stylus 1. All of the components of sampling, bandpass filtering, down sampling and
20 classifying can be implemented in a suitable computer program.

CLAIMS

1. A handwriting recognition system comprising:
means responsive to input analogue signals representative of movement of a
5 handheld writing device;
sampling means to provide signals representative of the acceleration of the
writing device in at least x axis and y axis channels at a predetermined capture
sampling rate; and
filtering means to remove dc level components and to provide smoothing of
10 the output whereby signals representative of movement of the pen over a period are
supplied to a classifier for comparison with a template representative of characters
formed.
2. A handwriting recognition system as claimed in claim 1, in which the
15 classifier uses a hidden Markov model for comparison purposes.
3. A handwriting recognition system as claimed in claim 1 or claim 2, in which
the sampling means, filtering means and classifier are implemented in a digital
computer environment.
20
4. A method of analysing signals from a moving handheld device, the method
comprising sampling signals at a predetermined rate, passing signals through a
bandpass filter to remove dc level and excess acceleration components, sampling the
filtered output to provide a series of vectors representing the position of the handheld
25 device at periodic intervals and using a classifier to compare the sample sets with
predetermined templates to determine the character for output.

Fig.1.



2/5

Fig.2.

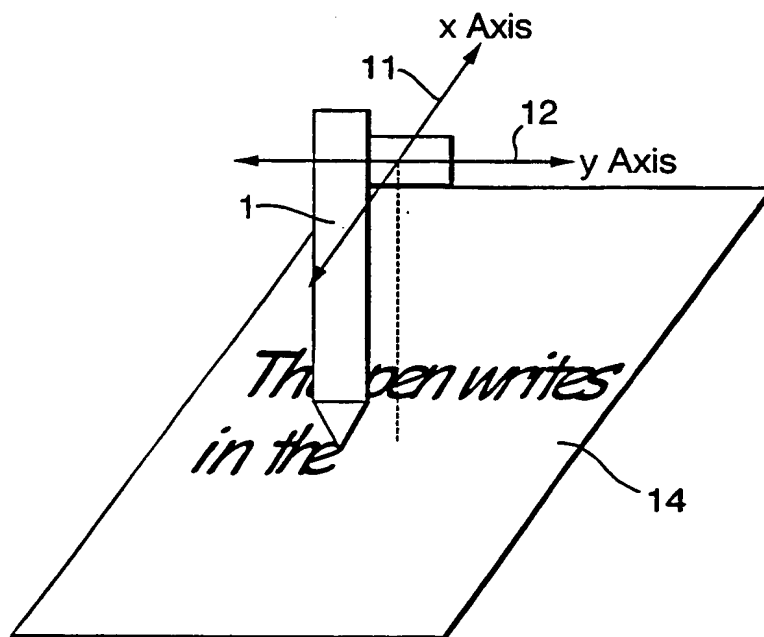


Fig.3.

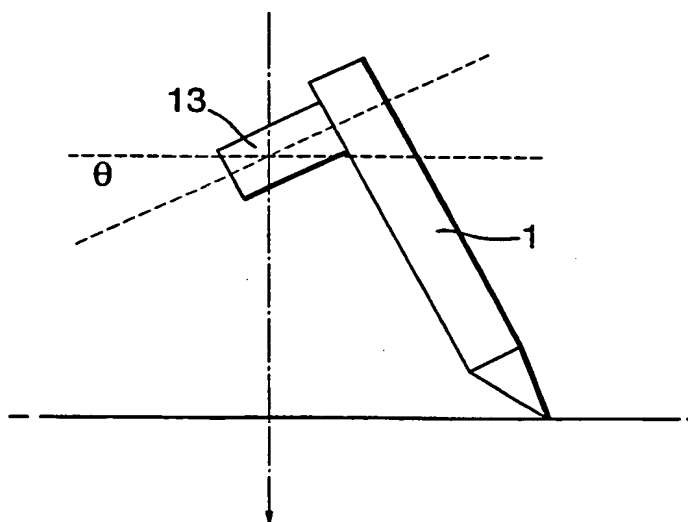


Fig.4.

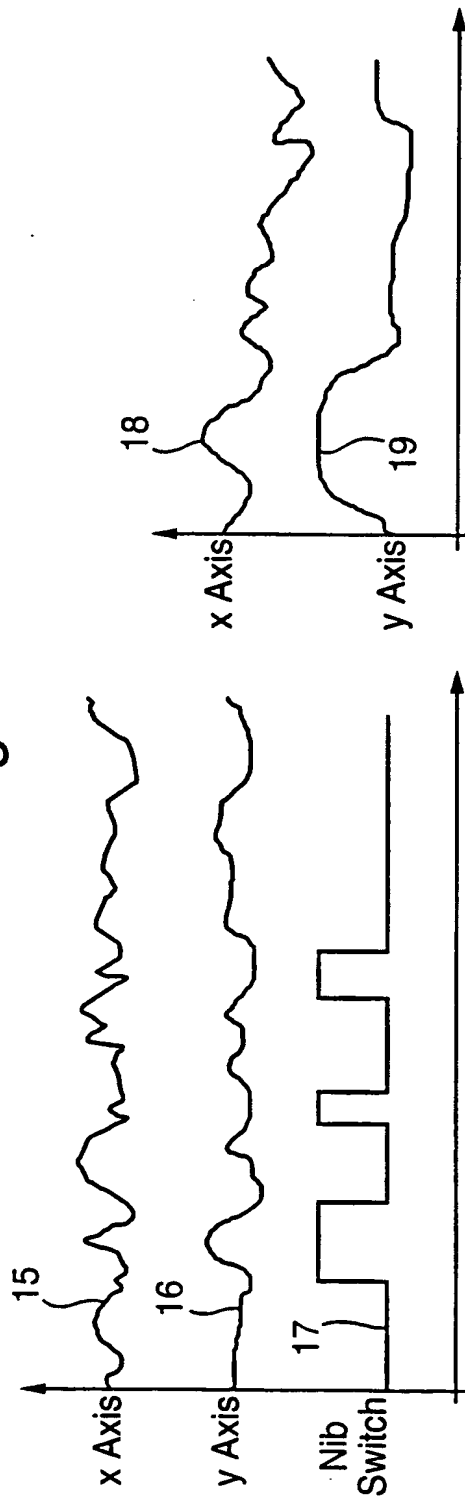


Fig.6.

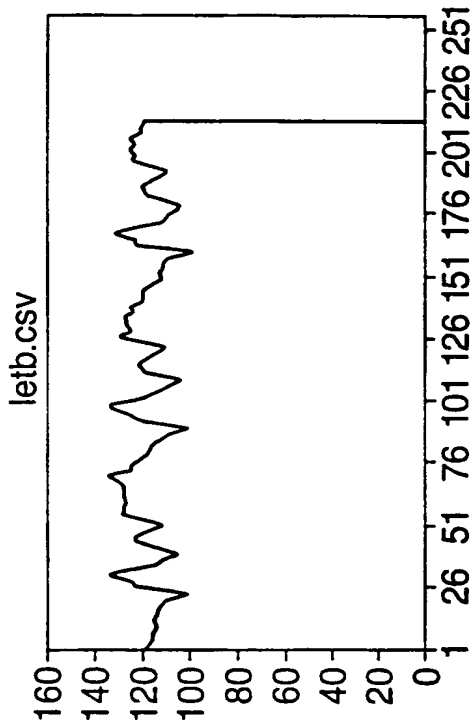


Fig.8.

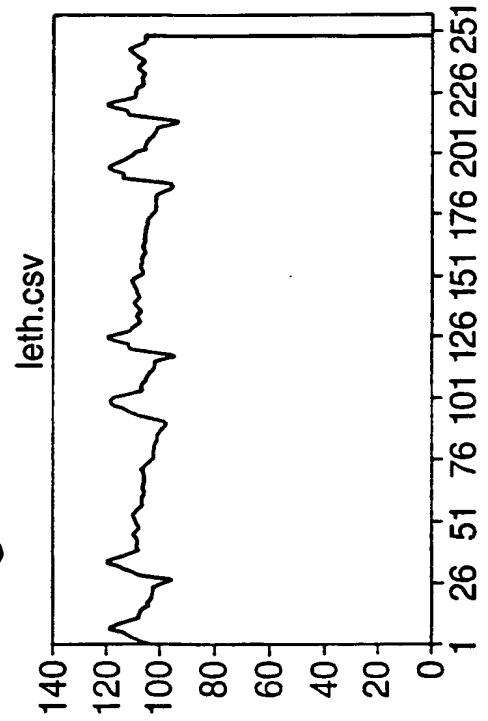


Fig.5.

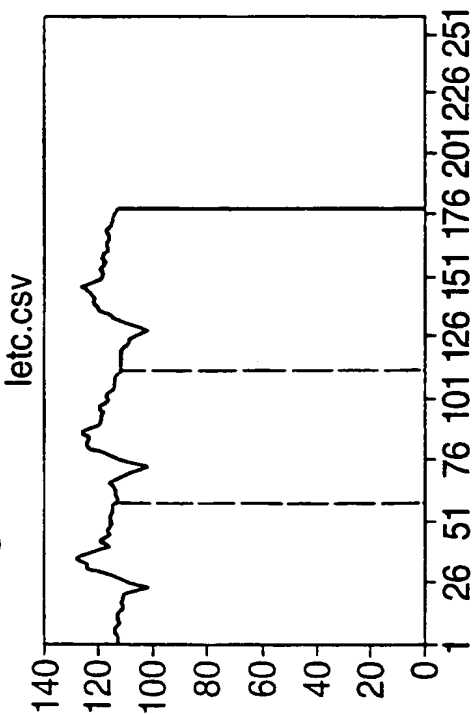
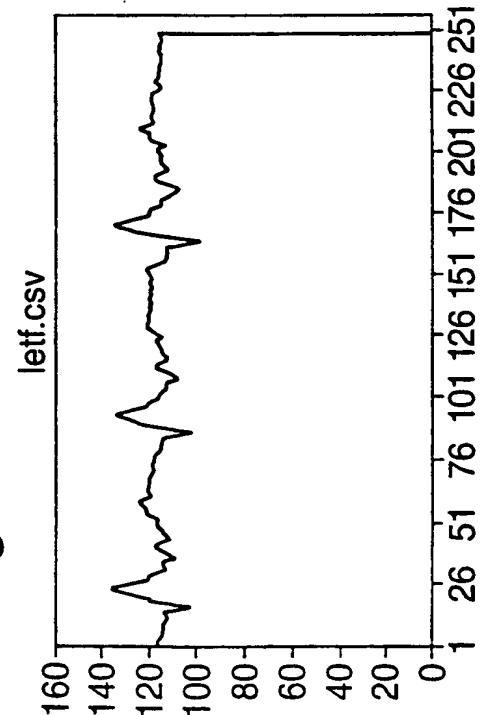
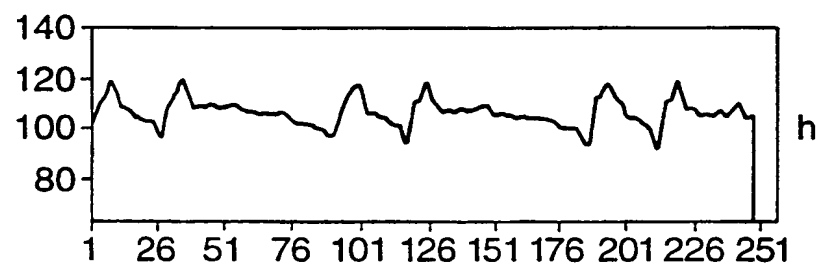
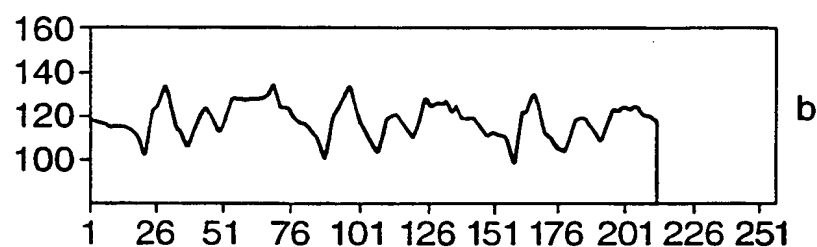
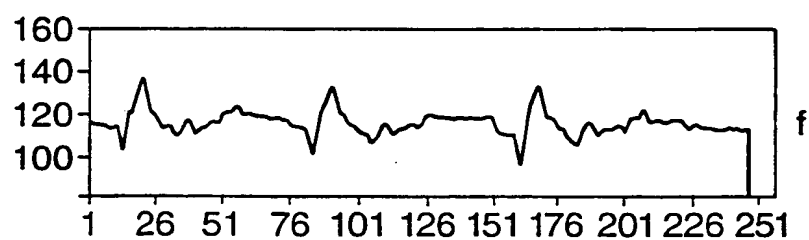


Fig.7.



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Fig.9.



INTERNATIONAL SEARCH REPORT

Inter. Application No

PCT/GB 00/01052

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G06K9/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 97 16799 A (GENOSSAR OMRY ;BARON EHUD (IL); BARON TECH LTD (IL)) 9 May 1997 (1997-05-09) abstract; figure 8 * page 15, last paragraph * * page 22, paragraph "STEP 330" * ---	1-4
Y	US 4 736 445 A (GUNDERSEN STEVEN C) 5 April 1988 (1988-04-05) column 41, line 60 -column 5, line 22 ---	1-4
Y	WO 97 44758 A (INST OF SYSTEMS SCIENCE ;APPLE COMPUTER (US)) 27 November 1997 (1997-11-27) abstract -----	2



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

28 June 2000

Date of mailing of the international search report

05/07/2000

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Sonius, M

INTERNATIONAL SEARCH REPORT

information on patent family members

Inter. Application No

PCT/GB 00/01052

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9716799 A	09-05-1997	AU 7330596 A	22-05-1997
US 4736445 A	05-04-1988	JP 62172478 A	29-07-1987
WO 9744758 A	27-11-1997	AU 3211897 A	09-12-1997
		CA 2252370 A	27-11-1997

P/ENT COOPERATION TREA

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

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 Office, PCT
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Date of mailing (day/month/year) 22 November 2000 (22.11.00)	
International application No. PCT/GB00/01052	Applicant's or agent's file reference A25731 WO
International filing date (day/month/year) 21 March 2000 (21.03.00)	Priority date (day/month/year) 24 March 1999 (24.03.99)
Applicant MILNER, Benjamin, Peter	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 18 September 2000 (18.09.00)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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